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ABSTRACT

A study investigated the effects of structure and interactivity on the achievement of students receiving Internet-based instruction. Structure was defined as the instructional strategy that provides the framework for the learning activity, giving the learner an advanced organizer. Interactivity was defined as the instructional strategy that provides the student the means of being actively involved in the learning activity. Participants were registered in 12 sections of Principles of Educational Media at Kent State University. They followed one of four instructional interventions incorporated within the course syllabus during the Instructional Design Module. Lessons covered use of the Internet/Web, introduction to instructional design, and writing objectives. In using Internet-based instruction, Designer's Edge provided the framework for learning the concept of writing objectives. Information Mapping of Web pages involved the participant in active learning with feedback on writing objectives. Two types of dependent measures were used: an achievement test for use as pretest/posttest and an attitude survey. Multivariate and univariate analyses of covariance were used to answer research questions. Findings confirmed that good design of Internet-based instruction improved student achievement of learning outcomes. The effects of structure were also significant. Recommendations for further research were made. (Contains 43 references.) (YLB)

EFFECTS OF STRUCTURE AND INTERACTIVITY ON INTERNET-BASED INSTRUCTION

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ABSTRACT

Internet-based instruction is acknowledged as a method of instructional delivery. However, there is limited research on its effectiveness. This study investigated the effects of structure and interactivity on the achievement of students receiving Internet-based instruction. Structure was defined as the instructional strategy that provides the framework for the learning activity, giving the learner an advanced organizer. Interactivity was defined as the instructional strategy that provides the student the means of being actively involved in the learning activity. Participants were registered in twelve sections of Principles of Educational Media at Kent State University. They followed one of four instructional interventions incorporated within the course syllabus during the Instructional Design (ID) Module. Lessons covered the use of the Internet/Web, an introduction to instructional design, and writing objectives. In using Internet-based instruction, Designer's Edge ™ provided the framework for learning the concept of writing objectives. Information Mapping® of Web pages involved the participant in active learning with feedback on writing objectives. This study confirmed that good ID of Internet-based instruction improves student achievement of learning outcomes. The effects of structure were also significant. This paper concludes with recommendations for further study.

ABOUT THE AUTHOR

Conrad Bills is an instructional technologist with the Tactical Defense Systems Division of Lockheed Martin at Akron, Ohio. He conducted this research on Internet-based instruction for his doctoral dissertation. He serves multiple training system programs in Instructional System Development (ISD), covering all phases of the ISD process. He joined Loral, now Lockheed Martin, in 1993 upon his retirement from the U.S. Air Force. Before his retirement, he directed the project that updated the Air Force ISD process. He was a training systems analyst for all of the Air Force Aircrew Training Systems (ATSs).

EFFECTS OF STRUCTURE AND INTERACTIVITY ON INTERNET-BASED INSTRUCTION

INTRODUCTION

The purpose of this study was to examine what effect the instructional interventions of structure and interactivity have on learning in Internet-based instruction. Additionally, this study served to provide the designers of Internet-based instruction with guidance on approaches for successful learning outcomes. Structure and interactivity were selected because of the prominence of these instructional strategies in the design of instruction with the predecessor media. These predecessor media include programmed instruction, computer-based training, and distance learning. The Instructional System Development (ISD) process was used in this study to design the instructional interventions. The prescription for teaching concepts was used to design the lesson on writing instructional objectives.

The Internet is a wide area network (WAN) composed of many local area networks (LANs). Some have referred to the Internet as the network of networks. The Internet has captured the attention of educators, administrators, and politicians throughout the country. According to Hill and Misic (1997), the Internet has become the main component in the National Information Infrastructure. The network associated with this concept, called the National Research and Education Network (NREN), is projected to be installed in schools, universities, and libraries. Eventually NREN is to be available to individual homes, to provide advanced communications capabilities to educators, researchers, business, and the general public. President Clinton and Vice President Gore announced earlier this year that $11.8 million in grants would be made available to schools for linking to the Internet. Along with this announcement, the Federal Communications Commission offered $2 billion in discounts to schools and libraries for Internet service. States throughout the nation such as Ohio and California have expanded their resources to get their schools plugged into the Internet. In 1995, Ohio instituted SchoolNet and SchoolNet Plus to wire the state's 100,000 public classrooms for voice, video and data transmissions (Galloway, 1995). In 1996, a group called California Net Day established the goal of wiring 20% of the state's 13,000 public and private schools wired to the Internet by the end of the year (Weiss, 1996).

Internet-Based Instruction

The primary focus of Internet applications in education is to open access to a wide variety of information and to connect students together for the purpose of sharing information (Hill & Misic, 1997). Ryder and Hughes (1997) noted that when educators became more familiar with the Internet, they also became increasingly aware of the need to include other forms of instruction. The availability and increasing ease of use of the Internet has expanded the use of the Internet for distance learning (Ellsworth, 1997). Suppliers of Internet-based instruction found in the World Wide Web pages include universities and colleges as well as commercial and private groups. Marklein (1997), reporting the results of Yahoo's most-wired college-campus survey, indicated that 45% of Internet usage was accounted for under "academics," and 99 of the top 100 campuses offered unlimited access to the Web.

Besides American schools, the Internet is rapidly becoming the preferred means of disseminating information in the work place. The International Data Corporation reported that 73% of all corporations of 1,000 employees or more will have intranets in 1997 and work-related training seminars on the Web are becoming more common. The interactive-training market is expected to exceed $1 billion by the year 2000 (Kasten, 1997). Educational materials are increasingly streaming toward the Internet. Recently, a vice president of one of the country's largest educational publishers said that the Web enabled their company to make pricing much more attractive (Weiss, 1996).

The interest in using the Internet for delivery of instruction has been spurred on by technological advances. These include the advent of graphical interfaces such as Mosaic™ and Netscape™, the increase in availability of Internet service providers, the increasing speed with which computers can communicate, and the advances in Internet software (HTML, VRML, Java). Booker (1997) reported that the improved version Web HTTP server protocol would speed up Web page download times four- to eightfold and cut Web bandwidth requirements by 35%.

Design of instruction for predecessor media to Internet-based instruction has followed the Instructional System Development (ISD) process. The origin of structure

and interactivity as central instructional strategies came from the formative years of ISD.

Instructional System Development

Instructional System Development (ISD) is the process for deliberate and orderly, but flexible planning, development, implementation, and management of instructional systems. Use of the ISD process has consistently improved the effectiveness of instruction (AFMAN 36-2234; Gagné, Briggs, & Wager, 1992). One root of ISD came from the early days of programmed instruction (Bills, 1996). Programmed instruction fostered an understanding of structure and interactivity that led to the conceptualization of the first systems approach to training (SAT). The systems approach is basically an empirical process for designing and improving instruction. Branson (1987) attributed the SAT process to work at the Air Force Human Resources Laboratory in 1953. After a study of the effectiveness of programmed instruction compared to classroom lecture, Head (1964) reported that students acquired the objectives in 33% less training time and student achievement scores increased by 9%. Goldman (1994) saw an evolution of instructional system development techniques and processes as designers focused on improving instructional effectiveness. Attention shifted from the specific applications of programmed instruction to a broader view, reaching across whole instructional systems.

Over time a standardized heuristic of ISD evolved for the design of instruction now known today as instructional system development (Dalton, 1994). Consistent in the models of ISD are the systematic phases of analysis, design, development, and implementation, with evaluation across every phase. The ISD process provides a systematic approach for designing instructional technology applications. The ISD process guides instructional designers in proven methods of integrating instructional technology into learning environments. Research on the ISD process has addressed the issue of instructional effectiveness (Dick & Carry, 1996; Gagné, Briggs, & Wager, 1992; Merrill, Li, & Jones, 1990; Reigeluth, 1983; Tennyson & Michaels, 1991). Generally, poor course outcomes from self-paced instruction were almost always the result of poorly designed materials or poor implementation, not the method of delivery (Semb, Ellis, Montague, & Wulfeck, 1991). Researchers found common principles of instructional design that will yield optimal learning (Spector, Polson & Muraida, 1993). The first principle is different learning objectives require different instructional strategies (Gagné, 1985).

The instructional design process was used to development the instructional interventions for this study. Of the variety of instructional strategies available, two prominent strategies of structure and interactivity were selected from the predecessors of Internet-based instruction.

Structure. Structure is defined in this study as an instructional strategy that shows students how the instructional material is organized and how it relates to what they have previously learned. External structure serves the function of activating internal events of information processing. The structure of the instructional material can act as an advance organizer to facilitate student learning. Advance organizers promote more meaningful learning and consequently facilitate the application of learned information to new situations (Ausubel, Novals & Hanesian, 1978).

This study uses a lesson on writing instructional objectives with a student population in the College of Education. Dick and Carey (1996) noted a difficulty in the past occurred when the training of teachers in how to write instructional objectives failed to make the process of defining objectives an integral component within a total instructional design model. Without the framework of instructional design, teachers did not have the context from which to derive the objectives.

Software tools have been developed that provide the framework of instructional design for instructional designers. These tools can also be used in teaching the ISD process. The tool called Designer's Edge™ was selected for this study because of the graphical interface for organizing the phases of the ISD process and the tutorial approach for guiding a novice through each design activity. In this study, the students were taught the concept of writing instructional objects after they were presented the advance organizer for instructional design provided by Designer's Edge™. Through Designer's Edge™, students established the context for objective writing within the ISD process.

Along with the strategy of structure, this study investigated the use of interactivity in Internet-based instruction. Interactivity provides the method for keeping the student actively involved in the instruction.

Interactivity. Interactivity was defined as an instructional strategy that provides the student the means of being actively involved in the learning activity. The method is establishing the appropriate conditions for learning. Interactivity for the Internet-based lesson on writing objectives included learner activity, self-check exercises, and feedback. Interactivity results in learner centered instruction

where the student experience is like having personal interaction with the instructor. Flanders (1970) summarized detailed studies of student-teacher interaction in distance learning, one of the predecessor of Internet-based instruction. He concluded that increased interaction improves student achievement and attitudes toward learning (Flanders, 1970).

Information Mapping® was used in this study as the methodology for providing interactivity in the objective writing lesson. Information Mapping® was selected because of the mapping approach for interactivity that fit the Web page format. The information map was hyperlinked throughout the lesson to allow systematic progression of learner activity, progress check, and feedback. Additionally, the map allowed opportunity to return and review each of the objective writing concepts.

Structure and interactive instructional strategies were used in the design of the instructional interventions used for this study. The next section describes the four instructional interventions within the instructional program.

RESEARCH QUESTIONS

Study questions were tested using the instructional interventions. Specific research questions in this study on Internet-based instruction were as follows:

1. Will students receiving structured instructional intervention achieve more successful learning outcomes than students receiving the non-structured intervention?

2. Will students receiving the interactive instructional intervention achieve more successful learning outcomes than students receiving the non-interactive intervention?

3. Will students receiving both the structured and the interactive interventions achieve more successful outcomes than students receiving both the non-structured and the non-interactive interventions?

It was hypothesized that structure and interactivity would achieve successful student outcomes when implemented with Internet-based instruction.

METHOD

This study featured a completely crossed 2 x 2, instructional structure by interactivity, quasi experimental, factorial design with an appended control (Campbell & Stanley, 1966; Jenkins & Hatcher, 1976; Kerlinger, 1986). The factorial design had two levels of instructional structure (structure and non structure) and two levels of instructional interactivity (interactivity and non interactivity). Dependent measures included an achievement posttest and an attitude survey. The pretest was to be used as a covariate.

Subjects

The subjects of this study were undergraduate college students enrolled in twelve sections of Principles of Educational Media during Spring Semester at Kent State University, College of Education. Subjects were 77% female, primarily Caucasian, and average age (18-21 years of age) for undergraduate college students. Each section of Principles of Educational Media had preregistration of about 20 students per section for Spring Semester. With three sections making up an experimental group, the projected size of one of the four experimental groups for this study was about 60 students. One of the experimental groups was divided into two parts. One part had two sections for the experimental group and the other part had one section for the appended control group.

All students enrolled during Spring Semester were participants in the study since the instructional intervention was integrated into the course syllabus. Students were given common consent forms which gave them the option as to whether or not they wanted to complete the data collection instruments in order to be included in this study. Between students opting not to participate and attrition, the size of an experimental group was about 40 students.

Students followed one of four instructional interventions that were incorporated within the planned course syllabus for Principles of Educational Media. The portion of the course syllabus identified for this study was the Instructional Design (ID) Module. The ID Module includes a lesson on the use of the Internet/Web, an introduction to instructional design, and a lesson on how to write objectives.

Instructional Program

The objective for the ID Module was to "demonstrate competence in planning instruction by completing an instructional design document to be used as a guideline for the development of the mini-lesson" (Tipton, 1996, p. v). Preparation of the ID document included writing objectives for the mini-lesson. These objectives were required to include the following components: Audience (A), Behavior (B), Condition (C), and Degree (D). Examples of well-stated objectives that

fulfill the "ABCD" criterion were in the text (Heinich, Modlenda, Russell, & Smaldino, 1996; Tipton, 1996).

Instructional Interventions

Students followed one of four instructional interventions that were incorporated within the planned course syllabus for Principles of Educational Media. The portion of the course syllabus identified for this study was the Instructional Design (ID) Module. The ID Module included a lesson on the use of the Internet/Web, an introduction to instructional design, and a lesson on writing objectives. The instructional program for the ID Module included four instructional interventions. Each intervention included the introduction to the Internet/Web, introduction to instructional design, and the objective writing lesson.

Description of four instructional interventions

The four variants of instructional intervention for the ID Module were applications of structure and interactivity to Internet-based instruction. Structure was used in the instruction to build the framework for learning the concept of writing objectives. Interactivity was used to involve the student in active learning during the writing objectives lesson. The four variants of instruction for the ID Module are shown in Table 1.

All students began the ID Module with a lesson on using the Internet. The "Lesson Plan for Internet/Web Introduction" was scheduled for the PC Lab as an in-class, hands-on exercise. The Internet/Web lesson covered a review of computer applications in education, an introduction to the basics of Windows 95®, and direction on the use of Netscape Navigator™. Students used navigation, browser, and search tools on the Internet. Instruction about the Internet concluded with a discussion about safety and objectionable materials, including methods such as software and use policy for protecting students.

Netscape Navigator™ is a commercial software tool by Netscape Communications Corporation called a World Wide Web (WWW) "browser" that is used to view pages on the Internet. During periods in the PC Lab, student used the buttons at the top of the browser screen to navigate on the Internet. Students used the "Home" button to return directly to the first page that appears when opening the browser, the "Back" button to go back to the previous page accessed, and the "Go" button to go directly to a prior page seen during the session. Students opened a location using the site address and made a "Bookmark" for returning to the site at a future time.

The **structure and non-structure interventions** were the next class period following the introduction to the Internet. Both lessons covered the activities in the front-end of the ID process that lead up to writing instructional objectives. The non-structure intervention was a classroom lesson on instructional design. The structured intervention used the "Lesson Plan for Instructional Design Lesson using Designer's Edge™," scheduled for the PC Lab as an in-class, hands-on exercise.

Designer s Edge ™ is an instructional design software tool from Allen Communications, Inc., used to guide a student through the sequence of activities of a computer-based instructional design project. Each phase of the instructional design process is shown as a block and the complete set of blocks is shown on the same screen. These blocks are programmed as buttons that open into the activities required for each phase. Wizards are provided to fill out key design documents and reports. Help is provided for instructional design using the "Advice" button. During the PC Lab, students viewed the introductory screen to see the "big picture" of instructional design. They completed six activities during which they identified instructional needs, set instructional goals, defined the student profile, and used the objective writing wizard to prepare an instructional objective.

The **interactivity and non-interactivity interventions** followed the "Lesson Plan for Objective Writing Lesson using Netscape™," except that each intervention was assigned a different address. The interactive intervention used the following Internet address: http://www.edu.kent.edu/writingobj. The non-interactive intervention used the address: http://www.edu.kent.edu/objectives. This lesson was scheduled for the PC Lab as an in-class, hands-on exercise. Both forms of the objective writing lesson covered the audience, behavior, condition, and degree (ABCD's) of well-written objectives, focusing on the behavior, condition, and degree (BCD) part of writing objectives. The lesson started with the definition, levels, and characteristics of objectives (ABCD). Following the overview, the behavior (B), condition (C), and degree (D) concepts were presented, each in the sequence for teaching a concept (Horn, 1992; Merrill, Tennyson, & Posey, 1992). For example, the Web page on identifying behaviors began with a definition of the behavior part of an objective. The definition was followed by examples and non-examples. The information used in the objectives writing lesson was adapted from the Air Force Manual

Table 1

Four Variants of Instruction by Structure and Interactivity

	Structure	Non Structure
Interactivity	Internet Introduction (PC Lab) Designer's Edge™ (PC Lab) Info-Map® Writing Objectives (interactive, PC Lab)	Internet Introduction (PC Lab) Instructional Design (classroom) Info-Map® Writing Objectives (interactive, PC Lab)
Non Interactivity	Internet Introduction (PC Lab) Designer's Edge™ (PC Lab) Objective Writing (linear, PC Lab)	Internet Introduction (PC Lab) Instructional Design (classroom) Objective Writing (linear, PC Lab)

Note: The network for linking the student personal computer laboratory (PC Lab) to the Internet is relatively new. Prior to this study, the PC Lab was upgraded to the Windows 95® operating system.

on Instructional System Development (AF Manual 36-2234, 1993).

The interactive lesson followed each concept presentation with a student practice exercise and feedback. The opportunity was always available to review by navigating through the lesson using the Info-Map®. The interactive lesson was organized using the Information Mapping™ approach to presenting instructional content (Horn, 1992), beginning with the lesson table-of-contents. The lesson was authored with the HyperText Markup Language (HTML) using the Netscape Gold™ editor. Key words were linked from the table of contents to the appropriate Web pages. During the lesson the student as allowed to use the key words to return to the table of contents and then branch to a desired part of the lesson for review.

Information Mapping® is a method for focusing on the information that the audience needs and presenting the information so that the need is met. Many believe this chunking and segmenting of text and content will aid comprehension (Gagné, 1965, 1985; Horn, 1992; Ormrod, 1990). Information maps provide a way to navigate directly to the information desired, meet the need, and then get on with the matter at hand. Information map navigation fits well in the context of Web page navigation and was used in the objective writing lesson, starting with the lesson table-of-contents.

The non-interactive lesson is a linear version of the objective writing lesson with the same content as the interactive lesson. However, the table of contents was removed, the opportunity for practice and feedback was removed, and the navigation to other parts of the lesson was removed. Thus, the opportunity for review was eliminated.

Description of Appended Control.

The appended control was the section enrolled in the course that did not receive the instructional interventions for this study. The control group syllabus was altered so students went through an unrelated module during the period of this study and then took the dependent measures before beginning the ID Module.

Dependent Measures

Two types of dependent measures were used for this study: (a) an achievement test, and (b) an attitude survey. Two achievement tests were written in the same format, one for use as the pretest and the other for use as the posttest.

Pretest and Posttest Description

The pretest and posttest were each composed of 30 test items. These 30 test items were presented in three parts with ten items in each part. The first set of test items covered the Behavior element in an objective; the second set covered the Condition; and the third set the Degree. Student response to a test item was limited to YES or NO choice. Students were asked to circle the answer that indicated whether or not the statement was written correctly. The choices were in three sets of ten items each as follows: learner behavior (performance), conditions of performance, and degree of acceptable performance.

Attitude Survey Description

The Student Survey was to gain insight into a student's experience during the ID Module. Students were asked to indicate the choice that best represents their answer. They were to circle one of the following five choices on a Likert scale: (a) Strongly Disagree; (b) Disagree; (c) Neither Agree nor Disagree; (d) Agree; and (e) Strongly Agree. The survey had 10 items broken out as follows: three on instructional media, two on instructional design, two on writing instructional objectives, and three on Internet-based instruction.

Validity of Instruments

The criterion-referenced tests were constructed from actual items presented in previous college courses as examples and non-examples for teaching the BCD concepts in writing instructional objectives. Items were developed and administered by a panel of instructional design experts over a five to seven year period. The test items were sorted in the same BCD order as the instructional sequence used in the objective writing lesson. These test items came from actual lessons on writing objectives prepared for similar class populations as that used for this study. Instructors had used these items over several years to gain feedback about student achievement of the BCD concepts.

The attitude survey used a Likert type scale or summated rating scale. According to Kerlinger (1986), the summated rating scale seems to be the most useful for an attitude survey in behavioral research. He explained that this scale is not only easier to develop, but also yields about the same results as the equal-appearing interval scale. The attitude survey items were directly related to aspects of the instructional intervention.

Reliability

Reliability analysis was completed for each dependent measure, the achievement test (pretest and posttest forms) and the attitude survey. The achievement test reliability analysis is presented by the three subtests (behavior, condition, and degree). The posttest had stronger reliabilities (alpha 0.67, 0.70, 0.35, respectively) than the pretest (alpha 0.48, 0.35, 0.29, respectively). The reliability analysis for the attitude survey resulted in an alpha of 0.85.

Formative Evaluation

Formative evaluation activities were used to validate the objective writing lesson. Once the content of the objective writing lesson was in the Internet-based instruction format, the lesson was administered in an individual tryout and an instructional design tryout. Out of these tryouts, the only corrections required were minor HTML changes dealing with the mechanics of the navigation.

Design and Data Analysis

This study used a completely crossed 2 x 2, instructional structure by interactivity, quasi experimental, factorial design with an appended control (Campbell & Stanley, 1966; Jenkins & Hatcher, 1976; Kerlinger, 1986). The factorial design had two levels of instructional structure (structure and non structure) and two levels of instructional interactivity (interactivity and non interactivity).

Students in all five experimental groups received the same dependent measures. Dependent measures included an achievement posttest and an attitude survey. The first day of class for the respective section, students completed the demographic survey and took the pretest. The last student activities for the objective writing lesson were taking the posttest, the same format as the pretest, and completing the attitude survey. Initial data analyses were completed with Multivariate Analysis of Covariance (MANCOVA) procedures, using the parallel form pretest as the covariate. Significant MANCOVA effects were analyzed further with Analysis of Covariance (ANCOVA) procedures for each dependent measure.

RESULTS

The effects of the four instructional interventions were analyzed using the combined score of the posttest and the combined score of the attitude survey. Descriptive statistics for the dependent measures are presented by instructional intervention in Tables 2 and 3. Multivariate and univariate analyses of covariance were used to answer the research questions.

Multivariate Analysis of Covariance (MANCOVA)

The multivariate analysis of covariance examined the overall effect and the interaction effects of the instructional strategies examined in this study on the dependent variables, using the pretest as the covariate. The univariate homogeneity of variance tests confirmed that there are no significant differences between the variables. This result confirmed that the variables likely shared a common conceptual meaning (see Table 4).

Table 2

Posttest Descriptive Statistics by Instructional Intervention

	Structure		Non-Structure		Total	
Interactivity	M	22.23	M	20.00	M	21.11
	SD	4.31	SD	4.56	SD	4.55
	N	44	N	44	N	88
Non-Interactivity	M	22.44	M	21.90	M	22.22
	SD	3.67	SD	3.82	SD	3.72
	N	45	N	31	N	76
Total	M	22.34	M	20.79	M	21.63
	SD	3.98	SD	4.35	SD	4.21
	N	89	N	75	N	164
Control					M	20.20
					SD	4.68
					N	15

Table 3

Survey Descriptive Statistics by Instructional Intervention

	Structure		Non-Structure		Total	
Interactivity	M	25.07	M	26.52	M	25.80
	SD	4.33	SD	3.59	SD	4.02
	N	44	N	44	N	88
Non-Interactivity	M	25.04	M	26.39	M	25..59
	SD	4.38	SD	3.84	SD	4.20
	N	45	N	31	N	76
Total	M	25.06	M	26.47	M	25.70
	SD	4.33	SD	3.67	SD	4.09
	N	89	N	75	N	164
Control					M	26.93
					SD	3.92
					N	15

The Wilk's Lamba criterion for multivariate analysis showed there is a significant multivariate effect attributed to the instructional interventions overall ($F(2, 158) = 11.25$, $p < .01$) and to structure ($F(2, 158) = 6.71$, $p < .01$). There was no significant multivariate effect attributed to interactivity ($F(2, 158) = 1.91$, $p = 0.15$) and to the interaction of structure and interactivity ($F(2, 158) = 0.32$, $p = 0.72$). A summary

Table 4

Homogeneity of Variance for All Groups

Scale	DF	F*	Sig of F
Pretest	3, 4365	1.48	NS
Posttest	3, 4365	0.85	NS
		C**	Sig of C
Survey	40, 4	0.29	NS

* Bartlet-Box
** Cochran

of the results of the multivariate analysis of covariance is shown in Table 5.

Univariate Analysis of Covariance

The univariate analysis of variance for each dependent variable showed significant results for both achievement and attitude attributed to instructional interventions overall ($F(1, 159) = 20.85$, $p < .01$; $F = 4.55$, $p < .05$). There was also a significant univariate effect for achievement attributed to structure ($F(1, 159) = 7.25$, $p < .05$). There was no univariate effect for achievement or attitude attributed to interactivity ($F(1, 159) = 3.69$, $p = .06$; $F = 0.00$, $p = .98$). There was also no univariate effect for achievement or attitude attributed to the interaction of structure and interactivity ($F(1, 159) = 0.36$, $p = .55$; $F = 0.19$, $p = .66$). A summary of the results of the univariate analysis of covariance is shown in Table 6.

Attitude Survey Analysis

Results of the attitude survey were assessed in context of achievement. When addressing instructional media, 87% of the participants felt that media can enhance their teaching or the teaching of those they support, 88% felt their students could benefit from wise use of media, and 93% knew good media design also requires well-planned instruction. Considering the instruction they experienced, only 55% felt the instruction they had received on instructional design and writing objectives was helpful to them. When asked about the benefit of Internet-based instruction, 78% felt the Internet is a good medium for delivery of instruction.

Two items related directly to the instructional interventions of structure and interactivity. When asked if the structure helped them get the "big picture" instructional design, 46% of the students in the structure group agreed. In comparison, 53% of the interactivity group who said structure was beneficial. When asked if the interactive course on instructional objectives was helpful, 46% of the structure group agreed, compared to 53% of the interactivity group.

DISCUSSION

This study investigated the effects of structure and interactivity on Internet-based instruction. Specific research questions in this study are related to the results as follows:

1. Will students receiving structured instructional intervention achieve more successful learning outcomes than students receiving the non-structured intervention? The answer to this question was yes. Students receiving the structured intervention, using the Designer's Edge™ framework, did do significantly better than students receiving the non-structured intervention ($F = 7.25$, $p < .05$). The relationship between the structured and non-structured delivery strategies is shown in Figure 1.

2. Will students receiving the interactive instructional intervention achieve more successful learning outcomes than students receiving the non-interactive intervention? The answer to this question was no. Students receiving the interactive intervention, using Info-Map® Writing Objectives approach, had no significant different in achievement from students receiving the linear, non-interactive intervention ($F = 3.69$, $p = .06$).

3. Will students receiving both the structured and the interactive interventions achieve more successful outcomes than students receiving both the non-structured and the non-interactive interventions? The answer to this question was also no. Students receiving both the structure and interactive intervention did not achieve better than other students ($F = 0.36$, $p < .55$).

Structure

Only students receiving the structure intervention achieved successful outcomes. The results of this study suggest that Designer's Edge™ provided the instructional design model for promoting more meaningful learning (Gagné, 1964). The network lesson using Designer's Edge™ provided the advance organizer for setting up a student's internal schema needed to organize learning (Gagné, 1985). The advance organizer provided an external structure or "hat rack" to facilitate the encoding of the internal structure or schema for the lesson content. This

Table 5

Multivariate Analysis of Covariance (MANCOVA) of Achievement and Attitude by Instructional Intervention

Effect	DF	λ	F	Sig of F p<.05
Structure	2, 158	0.92	6.71	0.00
Interactivity	2, 158	0.98	1.91	0.15
Structure x Interactivity	2, 158	1.00	0.32	0.72
Overall	2, 158	0.88	11.25	0.00

Table 6

Univariate Analysis of Covariance (ANCOVA) for Achievement and Attitude by Instructional Intervention

Covariate	Scale	β	Std Error	T	Sig of T p<.05
Posttest	Pretest	0.34	0.08	4.57	0.00
Survey	Pretest	0.17	0.08	2.13	0.03

Effect	Scale	DF	MS	F	Sig of F p<.05
Structure					
	Posttest	1, 159	109.84	7.25	0.01
	Survey	1, 159	63.23	3.91	0.05
Interactivity					
	Posttest	1, 159	55.95	3.69	0.06
	Survey	1, 159	0.02	0.00	0.98
Structure x Interactivity					
	Posttest	1, 159	5.39	0.36	0.55
	Survey	1, 159	3.13	0.19	0.66
Overall					
	Posttest	1, 159	315.78	20.85	0.00
	Survey	1, 159	73.65	4.55	0.03

internal schema facilitated later student (Jonassen, 1988; Spears, 1983, 1985).

Spears (1985) described an instructional strategy in which the instructor first presented students with a "hat rack" or an initial structure for organizing information. He used the example of orienting student pilots on the actual aircraft before classroom instruction about the individual aircraft systems. With this structure in place, students had the requisite schema into which new information could be integrated. The structure is supported as more important than interactivity as an instructional strategy for Internet-based instruction. Petkovich

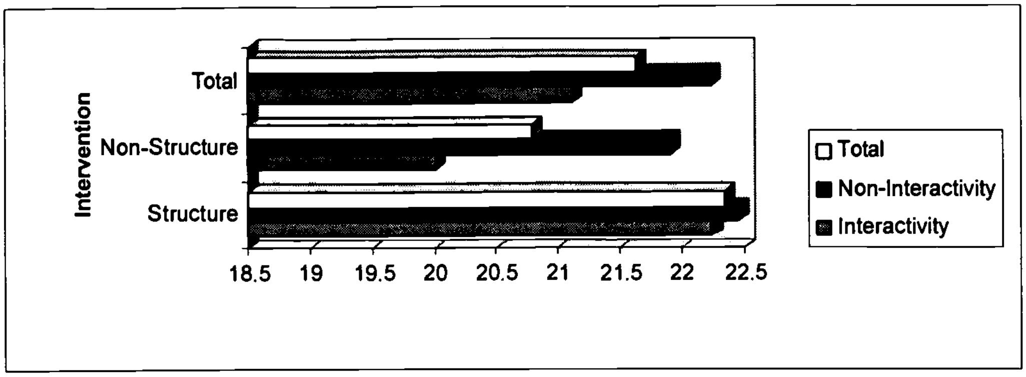

Figure 1: Combined Achievement Means By Instructional Intervention With Y-Axis Of Structure

and Tennyson (1984) noted that the cause of performance failure may be hat needed information was never initially obtained from the environment, forgotten, or incorrectly transformed. Meaningfulness in interactions comes about when the student accesses the appropriate schema from memory. The context for the response is the advance organizer. The mean of 22.23 for the structure interactivity group was higher than the mean of 20.00 for the non-structure interactivity group. Structure brought meaningfulness to the interactivity.

Interactivity

The non-significant result for the interactivity instructional intervention was unexpected. The non-interactivity group mean of 22.22 was moderately larger than the interactivity group mean of 21.11. This result is inconsistent with results of predecessor systems of programmed instruction.

Jonassen (1988) notes the importance of the depth of information processing required by responses in interactive instruction. Students in this study were novices at writing instructional objectives and using the Internet for receiving instruction. As a result, many may have had little knowledge on appropriate ways to interact with both the instructional content and the delivery system.

Internet-based instruction was delivered in a laboratory of personal computers for the individualized learning environment. Students were under the time constraint of a 50-minute period in which the lesson and the posttest were to be completed, answers checked, and the completed posttest returned to the instructor. Although there was time to complete the lesson within the designed 30-40 minutes, any difficulties caused students to feel rushed. Learner control over lesson options meant that students could opt out of interactivity by avoiding program options and hyperlinks. In other words, there may well have been little differences in the actual behavior of subjects in the interactivity and the non-interactivity groups.

The context of meaningfulness in interactivity combined with the prescription for teaching a concept can be explained by the approach called adjunct programming (Davies, 1972). Adjunct programming builds on prior learning by clarifying and adding emphasis, thus extending meaningfulness of the subject matter. Learning has been initiated before the student ever comes to the adjunct program. The advantage of this type of programming is that it can make use of textbooks and manuals already available to student and teacher. Powerful instruction may not need interactivity as defined by choosing links, active response to questions, and receiving feedback. Powerful instructional is internally or cognitively interactive (Spector, Polson, & Muraida, 1993). The optimal instructional design consisted of placing the objectives writing lesson in context of the instructional design model. Again, overarching interactivity was structure that seemed to be the key to achievement.

Second Generation Instructional Design

The robustness of instructional system development is in the prescriptive theory that identifies the instructional strategies appropriate for the different types of instructional goals (Davies, 1972; Merrill & ID_2 Research Group, 1996). A theory of instruction that will actually predict the conditions under which

a particular teaching strategy optimizes learning. Tennyson (1997) noted that instructional design is no longer tied directly to behavioral learning theory, but accounts for all learning theory in the formulation of the design prescription. "Everyone seems to agree that what's most lacking in both new and old authoring systems and also what's needed for the future, is more built-in instructional-design guidance" (Fritz, 1993, p. 55). Merrill (1993) described second generation instructional design (ID_2) as capable of producing pedagogic prescriptions for the selection of instructional strategies.

RECOMMENDATIONS FOR FURTHER RESEARCH

This study was an important first step in laying the ground work for future research in instructional design for Internet-based instruction. Future research needs to include other age groups and multiple learning domains. In addition to determining the instructional strategies that are most effective for the Internet, researchers need to determine what types of programs are best suited for this new medium of instruction.

Investigators establishing their research agenda need to establish a methodology for replicating their research with the right mix of subjects to allow generalization into the multiple settings of Internet-based instruction.

Methodologies need to take into account the primary focus of the Internet application, that of individualized instruction. This focus requires an understanding of learning theory as well as instructional design theory in order to achieve effective instruction. Learning models that are already confirmed across multiple groups, such as the information processing model (Gagné, 1965, 1985), may provide an expedient means for directing research that achieves generalizability across these groups.

This study was centered around one type of learning referred to as the intellectual skill of defined concepts (Markle & Tiemann, 1969). Since each type of learning requires different instructional prescriptions, future research needs to account for multiple learning domains and their respective prescription for instructional design. Investigators also need to keep in mind that in real life the types of learning are integrated (Gagné, 1993). These types of outcomes are often combined in complex education and training. Schema, enterprise, tacit learning, and metaskill are theoretical concepts that help facilitate understanding of integrated learning. Merrill and the ID_2 Research Group have identified instructional transactions across a continuum of learning types that may result in alternative learning strategies for an integrated approach to instructional design (Merrill & ID_2 Research Group, 1996).

Research on instructional strategies for Internet-based instruction must be tied to media attributes with the understanding of the conditions required for the learning activities and the application of the appropriate prescriptions to achieve the desired learning outcomes. The instructional theory is prescriptive, prescribing how learning can be improved. The learning theory is descriptive, describing what has happened after the event

What Goes on the Net

The Internet is touted as a world-wide information resource. In an effort to make more information available on the net, whole volumes are being transformed from print-based media to the net. Multimedia is expanding in Internet-based instruction applications. Technology for storing large digital information repositories is on the market. Methods continue to advance for the transferring the large digital audio and video files. The drive to stay up with this advancing technology can become so consuming that the misconception may develop of the Internet being the "end-all" answer to education and training. Impersonal technology "fads" add misunderstanding to the human dimensions of education and training. Unrestrained involvement without wise investment can quickly bankrupt the system. Therefore, the researcher's agenda needs to include the question, "What goes on the Net?"

CONCLUSION

Technology is no substitute for good instruction. A firm commitment to teachers is imperative. The good teacher is the "rubber band" in education and training because they can make up the difference in the shortcomings of media. Like any instructional media, the right integration of Internet-based instruction can promote learning. Research is needed to define the right role of Internet-based instruction in the paradigm for education and training.

Researchers should continue to assess the effectiveness of Internet-based instruction by empirical study as well as by instructional evaluation. This study provided an approach that was fruitful in adding to the understanding of good practices, but is far from conclusive in "what is best" for Internet-based instruction. What is emerging is a theory of instruction that will actually predict the conditions under which a particular teaching procedure optimizes learning. Attention should be given to the developments coming out of the research area of the next generation (ID_2) of instructional design (Merrill & ID_2 Research Group, 1996; Tennyson, 1997; Spector, Polson, & Muraida, 1993). This research provides the combination of efficiencies being developed for creating computer-based instruction with essential strategies for effective instruction.

A good approach for the design of Internet-based instruction would be to take the ID_2 outcomes, add the improved design tools for Web pages, and follow the sound methods of succinctly organizing information through Information Mapping®. The right approach will make the Internet more than a medium for delivery of information. It will truly become a medium for Internet-based instruction.

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